INSTRUCTION BOOK

FOR

NULL INDICATORS

MODEL NI-2 & NI-3

GERTSCH PRODUCTS, INC.
3211 So. LaCienega Blvd.
Los Angeles 16, California
UPton 0-2761 VErmont 9-2201

15 June 1961

WARRANTY POLICY

Gertsch Products, Inc. guarantees any equipment which we manufacture to meet the advertised performance specifications applying to that particular equipment.

Gertsch Products, Inc. warrants each instrument of its manufacture to be free from defects in material and workmanship. Our obligation under this Warranty is limited to servicing or adjusting any instrument returned to our factory for that purpose, and to making good at our factory any part or parts thereof except tubes, transistors, diodes, fuses, batteries or RatioTran potentiometers which shall, within one year after making delivery to the original purchaser, be returned to us with transportation charges prepaid, and which on our examination shall disclose to our satisfaction to have been thus defective.

Gertsch Products, Inc. reserves the right to make changes in design at any time without incurring any obligation to install same on units previously purchased.

This Warranty is expressly in lieu of all other obligations or liabilities on the part of Gertsch Products, Inc., and Gertsch Products, Inc. neither assumes nor authorizes any other person to assume for them any other liability in connection with the sales of Gertsch Products, Inc. instruments.

This Warranty applies only to the original purchaser unless approval for resale is obtained in writing from Gertsch Products, Inc.

Equipment----------

Serial No. ----------

Sold to ----------

Date Sold ----------

GERTSCH PRODUCTS, INC.
3211 South LaCienega Boulevard
Los Angeles 16, California

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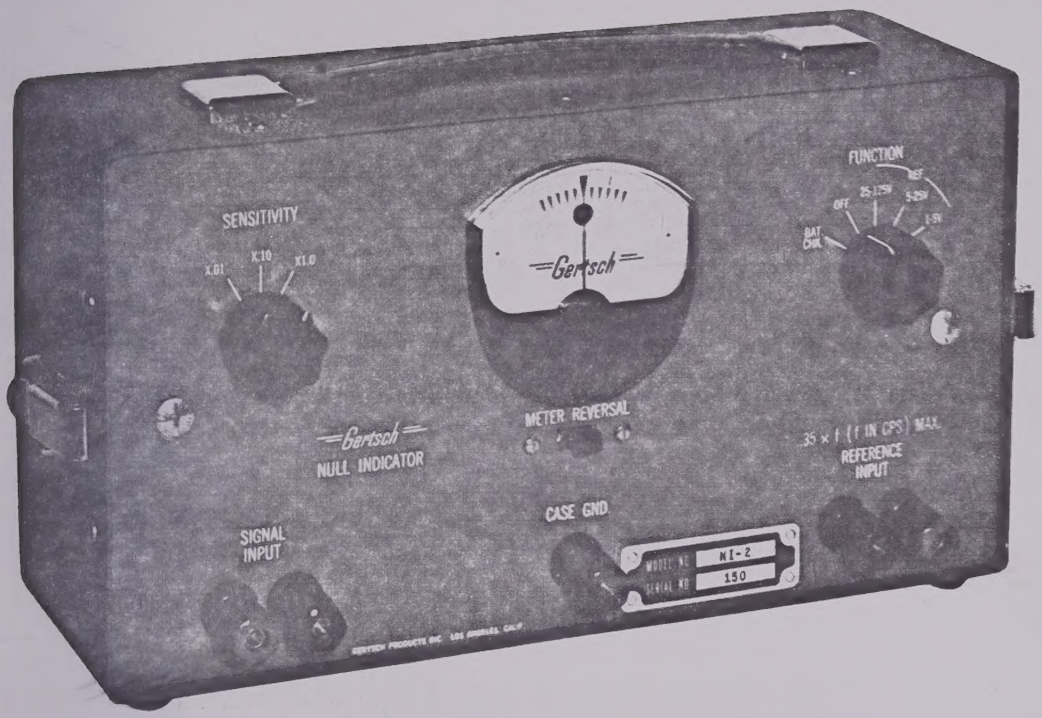

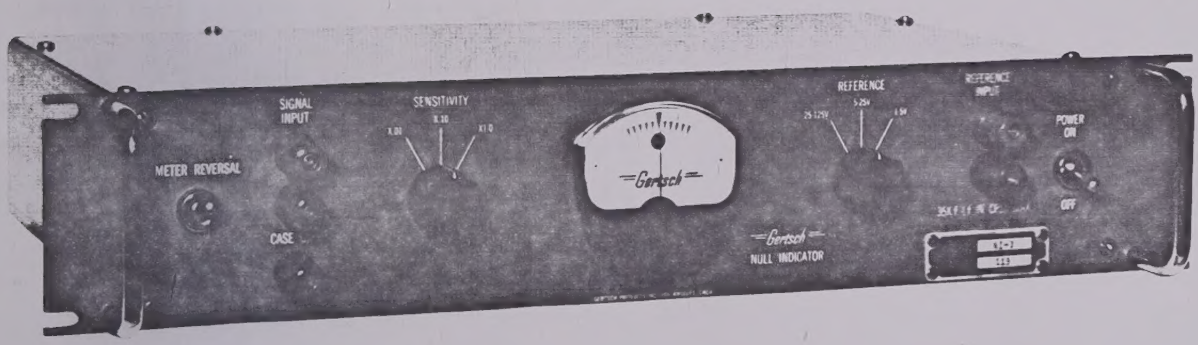

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FIGURE 1

MODEL NI-2 AND NI-3 NULL INDICATORS

SECTION I

GENERAL DESCRIPTION

The Model NI-2 and NI-3 Null Indicators, designed for use with any standard Gertsch RatioTran (Registered Trade Mark) to form an AC ratio bridge, are completely phase-sensitive transistorized instruments. Circuitry within the two instruments is similar except for the power supplies.

Model NI-2 is constructed on an isolated chassis which eliminates stray capacity and ground loop problems. The unit, which is mounted in a portable carrying case for convenient shop or laboratory use, is battery operated to provide complete portability. Auxiliary output jacks on the NI-2 provide a connection for using the amplifier section as a general purpose, wide-band (25 cps to 100 kc), pre-amplifier with an output impedance of 1000 ohms.

The NI-3 is constructed on an isolated chassis designed for installation in a standard 19-inch instrument rack. An integral AC power supply permits operation with an external 115/230 VAC power source. Amplifier output is not available for use except for self-checking amplifier gain.

Either null indicator may be combined with any standard Gertsch RatioTran to form an AC ratio bridge. When a RatioTran and null indicator are connected as illustrated (see figure 4), the sensitivity of the combination is such that a 10-microvolt change in the selected input signal to the null indicator is readily discernible on the zero-center null meter. Fundamentally, the null indicator consists of a wide-band, high-gain amplifier which drives a phase-sensitive

detector, the output of which energizes a null indicator meter. The reference voltage for the detector bridge is provided by driving an isolation transformer with the bridge circuit input to make the detector sensitive to the in-phase portion of the input signal being checked for a null condition. A zero-center null meter permits reading an over or under null condition. Three selectable ranges of sensitivity, 10, 100, or 1000 microvolts, and three selectable ranges of reference voltage, 1 to 5, 5 to 25, and 25 to 125 volts permit use of Model NI-2 and NI-3 Null Indicators in a variety of applications.

SPECIFICATIONS

The Model NI-2 and NI-3 Null Indicators meet or exceed the following specifications when operated in accordance with operating procedures contained in Section II of this instruction book.

NULL INDICATOR

Type		Phase-sensitive
Frequency Range		50 to 10,000 cps
Sensitivity		3 ranges; 10 uv, 100 uv, and 1000 uv
Input Impedance		1 megohm minimum
Reference Voltage Amplitude		3 ranges: 1 to 5 v, 5 to 25 v, 25 to 125 v } 0.35f (f in cps) max (21 volts at 60 cps)
Power	Model NI-2	2 internal 9-volt batteries with 140-hour life
	Model NI-3	115/230 VAC
Indicator		Zero-center null meter
Size	Model NI-2	12 x 7 x 5 inches deep
	Model NI-3	19 x 3-1/2 x 9 inches deep (rack mounting)

AMPLIFIER (Model NI-2 only)

Frequency Range	40 to 30,000 cps (3 db down from 1 kc at 40 cps and 30 kc)
Cutput Voltage	1 volt rms max without clipping
Noise (output referenced to input)	Equivalent to 15 uv (max)
Maximum gain	Approximately 7000

SECTION II

INSTALLATION AND OPERATION

INSTALLATION

Model NI-2 Null Indicator is a battery powered, preassembled, completely portable unit which may be used in the field or in the laboratory without an external power source. Since the unit is completely self contained, no installation procedures are required.

Model NI-3 Null Indicator is designed for mounting in a 19-inch instrument rack in the conventional manner. Four slots are provided to accommodate attaching hardware and handles on each end permit easy insertion of the unit into the instrument rack. A 115-volt, 50 to 1000 cps power source is required for operation of the unit.

FUNCTION OF CONTROLS AND CONNECTORS. (Refer to figures 2 and 3.)

To enable the operator to understand the operation of the unit, the functions of the controls and connectors are described in detail as follows:

SENSITIVITY

The SENSITIVITY control is a 3-position switch used to select the required attenuations between the input signal source and null amplifier.

This control provides a method of reducing the sensitivity of the null indicator circuit for ease in balancing the bridge circuit.

X .01 (attenuates by 100 for a 1000 uv input)

X .10 (attenuates by 10 for a 100 uv input)

X 1.0 (no attenuation for a 10 uv input)

SIGNAL INPUT

Signal input jacks provide a connection for the input signal from a bridge under test as follows: Red terminal is connected to the arm of the SENSITIVITY switch; Black terminal is connected to circuit common.

METER REVERSAL

A meter reversal control switch enables the operator to conveniently change the polarity of the detector output to the null meter to cause an over-null indication to fall to the right of meter zero-center and an under-null indication to fall to the left of meter zero-center, regardless of the relative phase of the input signal.

CASE GND.

The case ground jack provides a method of connecting the case or outer chassis to an external ground. CASE GND. is isolated from circuit common in the internal circuitry to eliminate stray capacity and ground loop problems.

FUNCTION (Model NI-2 only)

A 5-position rotary, function switch is used to select any one of the following positions:

BAT. CHK. Converts the null meter into a voltmeter enabling the operator to check the condition of internal power source batteries.

OFF — Electrically disconnects batteries from the unit.

1-5 V
5-25 V
25-125 V
} Select the desired reference voltage range

REFERENCE (Model NI-3 only)

A 3-position rotary, reference switch is used to select the desired reference voltage range as follows:

1-5 V
5-25 V
25-125 V

REFERENCE INPUT

Reference input jacks provide a connection for a reference input voltage source. Reference input voltage must be limited to 0.35 x frequency (frequency in cps) or 125 volts maximum to prevent possible damage to the reference transformer.

Auxiliary Output Jacks (NI-2 only)

Auxiliary output jacks are located at the rear of Model NI-2 Null Indicator to provide an outlet for using the amplifier section as a general purpose, wide-band, pre-amplifier.

(On Model NI-3 these jacks are located on the component board and may be used in checking amplifier gain only.)

POWER (Model NI-3 only)

POWER ON-OFF switch controls external 115-VAC input power to internal circuitry.

OPERATION

Operation procedures for the Model NI-2 and NI-3 Null Indicator (with the applicable Gertsch RatioTran connected into the circuit) are as follows:

1. Connect the null indicator into a bridge circuit as shown in figure 4.

2. Set REFERENCE switch (Model NI-3) or FUNCTION switch (Model NI-2) to a range coinciding with the reference voltage used.

CAUTION

Operating the unit with REFERENCE or FUNCTION switch in a range setting lower than the reference voltage input may result in overloading and damaging the null indicator circuits.

3. Set SENSITIVITY switch to proper position for desired signal input.

4. Set METER REVERSAL switch so that a below-null indication is to the left of meter zero-center or an above-null indication is to the right of meter zero-center.

NOTE

The actual direction of the meter deflection, versus bridge balance, depends upon the relative phase of reference input voltage (0° or 180°) and the signal.

5. Proceed with test. (Refer to operating input instructions for the applicable RatioTran used in test.)

SECTION III

THEORY OF OPERATION

GENERAL DESCRIPTION

The Model NI-2 and NI-3 Null Indicators consist of a high-gain, wide-band amplifier driving a phase-sensitive null indicator. The in-phase reference voltage for the null indicator is provided by an isolation transformer connected to the bridge input signal.

Referring to block diagram, figure 5, the input signal is fed into the attenuator stage which provides a direct input to the emitter followers. The attenuation reduces the input signal level and therefore needle deflection, which improves the resolution at null.

NOTE

During a test, the smallest signal change available may cause a large deflection of the meter movement (with the sensitivity switch at X 1.0 position). As an example, if a Gertsch RT-5 RatioTran is placed in the bridge circuit shown in figure 4, each step of the sixth place on the RatioTran is equal to $E_{in} \times 10^{-6}$. If E_{in} is 100 volts, each position of sixth place is 100 uv. With a meter sensitivity of 20 uv per division, a one step change at the sixth place on the RT-5 will result in a needle deflection of five divisions on the null meter. If a five place RatioTran is inserted instead, a one step change in the last place would be equal to 1000 uv or full scale meter movement. Placing the sensitivity switch in X .10 position will provide the necessary attenuation for easier balancing of the bridge.

The signal is then fed into the emitter follower stage which consists of two "bootstrap" connected emitter followers to provide a one megohm input impedance. This stage minimizes the "off-null" current and prevents possible damage to sensitive devices under test.

The input stage is followed by two RC coupled, "amplifier-pair" voltage amplifiers. Each amplifier-pair consists of two direct coupled transistors with a large amount of negative feedback to effectively stabilize the operating parameters.

The output of the last voltage amplifier drives the phase sensitive detector and is also available at the auxiliary output jacks. The reference transformer provides an in-phase reference voltage, derived from the bridge input signal, to the detector to make the detector sensitive only to the in-phase component of the null signal.

DETAILED CIRCUIT DESCRIPTION. (See figures 6 and 7.)

Switch S101A and B selects the desired attenuation (none, 10, or 100). The two steps of attenuation are accomplished by selecting a combination of resistors R101, R102, and R103, and capacitors C101 through C104. Variable capacitors C101 and C102 are included to adjust and improve the frequency response of the attenuator.

The "bootstrapped" emitter followers, Q101 and Q102 provide an input impedance of one megohm. Resistor R105 and clipping diodes CR101 and CR102 prevent overloading of the null amplifier circuits.

Transistors Q103-Q104 and Q105-Q106 are RC coupled "amplifier-pair" voltage amplifiers. Resistors R117 and R124 provide paths for a large negative DC feedback voltage which stabilizes the operating parameters of the circuits. CR103 and CR104 are clamping diodes which prevent the signal from exceeding the base/emitter ratings of the transistors. C113 is a peaking capacitor which improves the high frequency response of the input circuit.

The amplifier output is coupled through C118 to drive the phase detector. Any in-phase voltage applied to the junction of resistors R132 and R133 results in a deflection of the meter movement. Switch S102A and B on Model NI-2 and switch S106A and B on Model NI-3 reverse the polarity of the zero-center null meter. Switch S103 provides the function selection for Model NI-2 and switch S104A and B provides the reference selection for Model NI-3. Isolation transformer T101 provides the three reference voltage outputs selected by switch S103 and S104A and B.

External power to operate Model NI-3 is applied through switch S105 to power transformer T102. The secondary of T102 is connected to two legs of a full-wave rectifier bridge. Output from the bridge is filtered by resistor R139 and capacitors C120 and C121 and limited by diode CR113.

SECTION IV

MAINTENANCE AND ADJUSTMENT

MAINTENANCE

The Model NI-2 and NI-3 Null Indicator circuits are designed for highly stable and reliable operation, thus precluding the necessity of periodic adjustment. Except for battery replacement in the Model NI-2 or component failure, no maintenance is required. Replace batteries in the Model NI-2 when the needle deflection drops to or below the red line on the null meter when the function switch is in the BAT. CHK. position.

Most of the components in the units are standard radio parts and may be obtained from any local electronics parts dealer. Refer to

the parts list for required tolerances. Gertsch Products, Incorporated, will supply replacement parts at current net prices. The locations of the circuit components are shown in figures 8, 9, and 10.

ADJUSTMENTS

Internal adjustments are preset prior to shipment from the Gertsch Products, Incorporated, factory. Trimmer capacitors C101 and C102 are incorporated in the attenuator circuit to improve frequency response. If a component in the attenuator circuit is replaced, adjust the capacitors using the following test equipment and procedures:

TEST EQUIPMENT REQUIRED

High gain oscilloscope with low capacity probe. Signal generator, Hewlett-Packard, Model HP200CD or equivalent.

Attenuator, Gertsch Products, Incorporated, Model RT-5 Ratio-Tran, or equivalent.

ADJUSTMENT PROCEDURE (Refer to figures 8 and 9.)

1. Connect the RatioTran between the signal generator and SIGNAL INPUT jacks on the null indicator.
2. Connect oscilloscope vertical input to null indicator jacks J105 and J106.
3. Connect plus of signal generator to horizontal input of oscilloscope.
4. Set frequency output of signal generator to 10KC.
5. Set SENSITIVITY switch on null indicator to .01 and apply power to unit.
6. Adjust voltage output of signal generator until there is no clipping in the null amplifier.
7. Adjust capacitor C102 for minimum phase shift (as observed on

NOTE

This adjustment is made while comparing signals at the amplifier input and output. The comparison is presented as a Lissajous pattern on the oscilloscope. Capacitors are adjusted for minimum phase shift between the signals.

8. Set SENSITIVITY switch on null indicator to X . 1.

9. Repeat step 6.

10. Adjust capacitor C101 for minimum phase shift.

NOTE

Due to interaction between the trimmer capacitors, it is advisable to repeat steps 5 through 10.

SECTION V

PARTS LIST

SYMBOL	DESCRIPTION	MANUFACTURER	PART NO.
B101	Battery (MI-2 only) 8.4 V	Mallory	TR-146R
B102	Battery (MI-2 only) 8.4 V	Mallory	TR-146R
C101	Capacitor, trimmer ceramic 3-12 pF	Erie	503I5003-12
C102	Capacitor, trimmer ceramic 7-45 pF	Erie	503I5007-45
C103	Capacitor, silvered mica 500 pF	El-Menco	DM-15E-501-K
C104	Capacitor, tubular ceramic 15 pF	Centralab	TCZ-15
C105	Capacitor, metallized paper .5uf 200 V	Hopkins Eng. Co.	P52DS
C106	Capacitor, disc ceramic .001uf 500 V	Erie	801.001 Z5U

C107	Capacitor, electrolytic 15uf 12 V	Sprague	TE-1129
C108	Capacitor, electrolytic 15uf 12 V	Sprague	TE-1129
C109	Capacitor, disc ceramic .001uf 500 V	Erie	861.001 ZZ5U
C110	Capacitor, electrolytic 15uf 12 V	Sprague	TE-1129
C111	Capacitor, electrolytic 15uf 12 V	Sprague	TE-1129
C112	Capacitor, electrolytic 500uf 3 V	Sprague	TE-1068
C113	Capacitor, mylar .015uf 100 V	Goodall	663 UW
C114	Capacitor, electrolytic 300uf 6 V	Sprague	TE-1106
C115	Capacitor, electrolytic 15uf 12 V	Sprague	TE-1129
C116	Capacitor, electrolytic 500uf 3 V	Sprague	TE-1068
C117	Capacitor, electrolytic 15uf 12 V	Sprague	TE-1129
C118	Capacitor, electrolytic 300uf 6 V	Sprague	TE-1106
C119	Capacitor, electrolytic 15uf 12 V	Sprague	TE-1129
C120	Capacitor, electrolytic (NI-3 only) 250uf 50 V	Sprague	TVA-1312
C121	Capacitor, electrolytic (NI-3 only) 250uf 50 V	Sprague	TVA-1312
C122	Capacitor, metallized paper (NI-3 only) .5uf 200 V	Hopkins Eng. Co.	P52DS
CR101	Diode, silicon	Hughes	1N457
CR102	Diode, silicon	Hughes	1N457

CR103	Diode, germanium	Transitron	1N273
CR104	Diode, germanium	Transitron	1N273
CR105	Diode, silicon	Hughes	1N457
CR106	Diode, silicon	Hughes	1N457
CR107	Diode, silicon	Hughes	1N457
CR108	Diode, silicon	Hughes	1N457
CR109 thru CR112	Diode, silicon (NI-3 only)	Diodes, Inc.	DI-56
CR113	Diode, Zener (NI-3 only)	International Rectifier	1N1512
F101	Fuse, 115 V operation (NI-3 only) 1/16 AMP	Bussmann Mfg.	AGC1/16
F101	Fuse, 230 V operation (NI-3 only) 1/32 AMP	Bussmann Mfg.	AGC1/32
J101	Post, binding, red	Superior Electric	DF 30RC
J102	Post, binding, black	Superior Electric	DF 30BC
J103	Post, binding, red	Superior Electric	DF 30RC
J104	Post, binding, black	Superior Electric	DF 30BC
J105	Jack, test, red, banana	Johnson	108903
J106	Jack, test, black, banana	Johnson	108902
J107	Post, binding, black	Superior Electric	DF 30BC
J108	Connector, chassis (NI-3 only) AC power	Tower	H10610A
M101	Meter, null	GPI	AW-262
Q101	Transistor	TUNG-SOL	2N417
Q102	Transistor	TUNG-SOL	2N417

Q103	Transistor	TUNG-SOL	2N417
Q104	Transistor	TUNG-SOL	2N417
Q105	Transistor	TUNG-SOL	2N417
Q106	Transistor	TUNG-SOL	2N417
R101	Resistor, deposited carbon 1M 1% 1/2W		RN65B-1004F
R102	Resistor, deposited carbon 100K 1% 1/2W		RN65B-1003F
R103	Resistor, composition 10K 10% 1/2W		
R104	Resistor, deposited carbon 10M 1% 1/2W	IRC	MDC 1005F
R105	Resistor, composition 22K 10% 1/2W		
R106	Resistor, composition 180K 10% 1/2W		
R107	Resistor, composition 180K 10% 1/2W		
R108	Resistor, composition 100K 10% 1/2W		
R109	Resistor, composition 1.2K 10% 1/2W		
R110	Resistor, composition 22K 10% 1/2W		
R111	Resistor, composition 22K 10% 1/2W		
R112	Resistor, composition 4.7K 10% 1/2W		
R113	Resistor, composition 4.7K 10% 1/2W		
R114	Resistor, composition 8.2K 10% 1/2W		
R115	Resistor, composition, selected value (220 ohms 10% 1/2W NOM)		

R116 Resistor, composition 2.2K 10% 1/2W

R117 Resistor, composition 220K 10% 1/2W

R118 Resistor, composition 1K 10% 1/2W

R119 Resistor, composition 220 ohms 10% 1/2W

R120 Resistor, composition 1.8K 10% 1/2W

R121 Resistor, composition 4.7K 10% 1/2W

R122 Resistor, composition 8.2K 10% 1/2W

R123 Resistor, composition 2.2K 10% 1/2W

R124 Resistor, composition 220K 10% 1/2W

R125 Resistor, composition 1K 10% 1/2W

R126 Resistor, composition 470 ohms 10% 1/2W

R127 Resistor, composition 470 ohms 10% 1/2W

R128 Resistor, composition 220 ohms 10% 1/2W

R129 Resistor, composition 1.8K 10% 1/2W

R130 Resistor, composition (MI-2 only) 1M 10% 1/2W

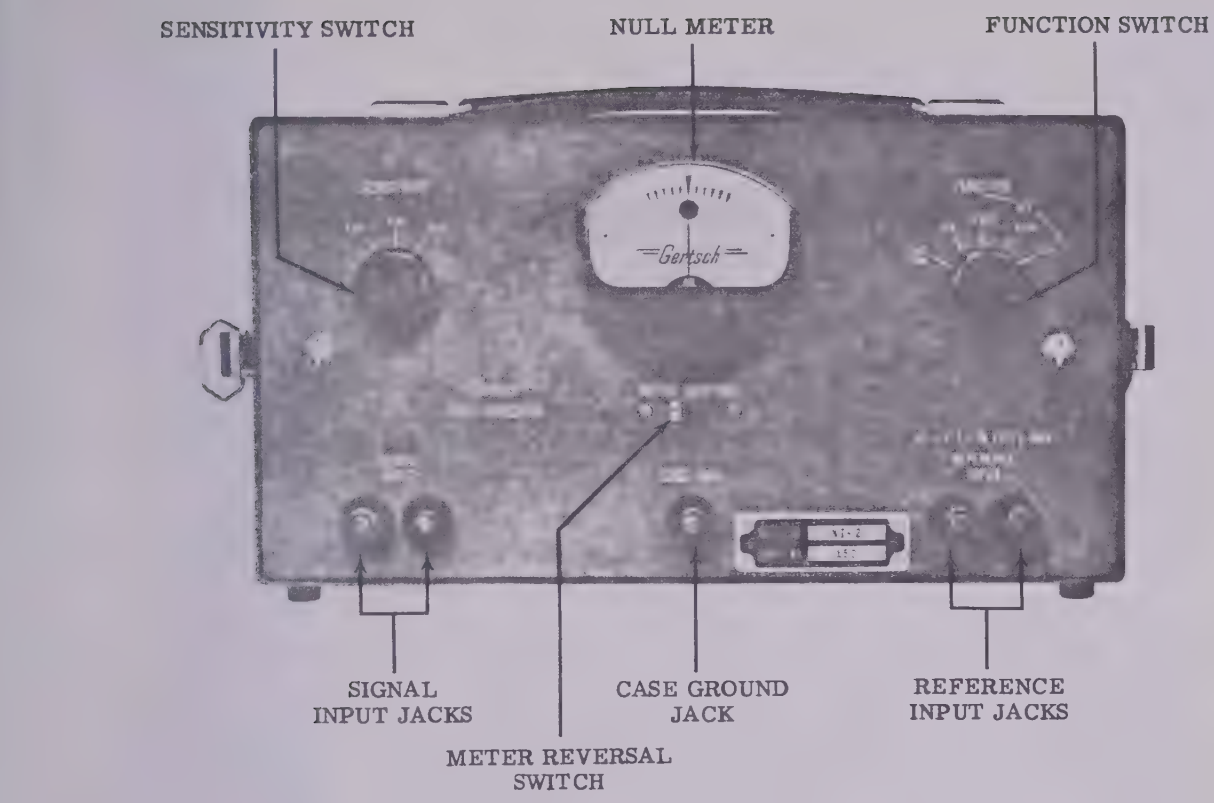
R131 Resistor, composition (MI-2 only) 1.5K 10% 1/2W

R132 Resistor, composition 47K 10% 1/2W

R133 Resistor, composition 47K 10% 1/2W

R134	Resistor, composition 2.2K 10% 1/2W		
R135	Resistor, composition 2.2K 10% 1/2W		
R136	Resistor, composition 2.2K 10% 1/2W		
R137	Resistor, composition 2.2K 10% 1/2W		
R138	Resistor, composition (NI-2 only) Factory selected, may not be required		
R139	Resistor, composition (NI-3 only) 680 ohms 10% 1W		
S101	Switch, rotary 1 wafer	GPI	SW-73
S102	Switch, slide DPDT (NI-2 only)	Continental Wirt	SW-726
S103	Switch, rotary 3 wafer (NI-2 only)	GPI	SW-72
S104	Switch, rotary (NI-3 only)	GPI	SW-73
S105	Switch, toggle (NI-3 only)		ST-26
S106	Switch, toggle (NI-3 only)		ST-26
T101	Transformer, reference input	GPI	TA-165
T102	Transformer, power (NI-3 only) 115 V PRI	GPI	TA-182
T102	Transformer, power (NI-3 only) 115/230 V PRI	GPI	TA-201
TB101	Terminal board with two links (NI-3 only) 115/230 V	Cinch	1774/ 5101P24
XF101	Fuseholder, 3AG MINIATURE (NI-3 only)	Littelfuse	342003
	Connector, battery (2 required) (NI-2 only)	Ucinite	154993-SA
	Knob, switch (2 required)	GPI	AA-537

SUBSTITUTIONS: When expedient, equivalent components may be substituted at the factory. Performance will not be impaired. When making replacements, either parts in this list or the substituted equivalent may be used.



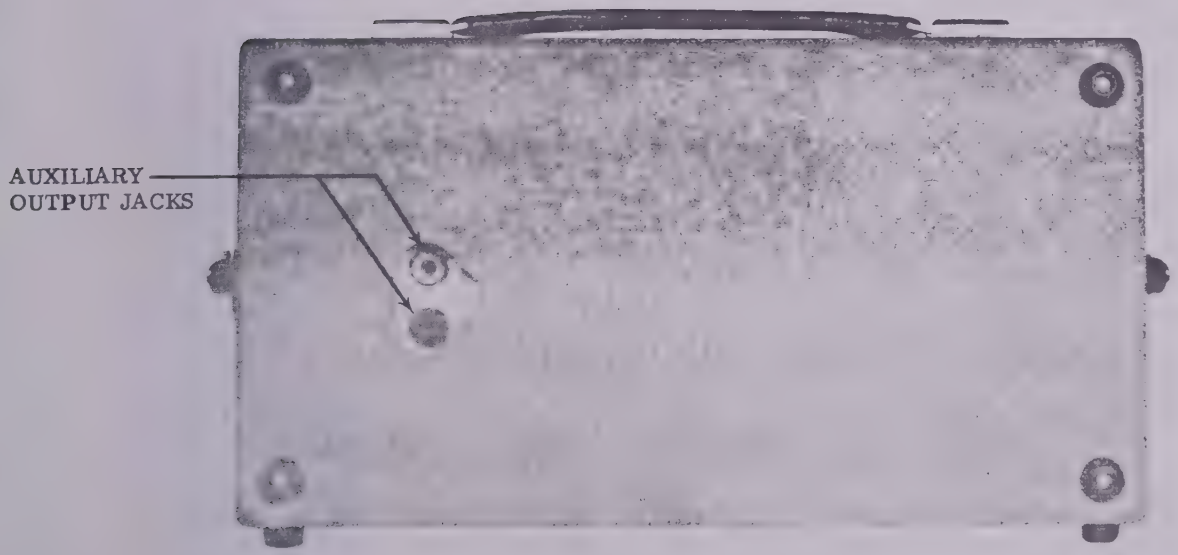


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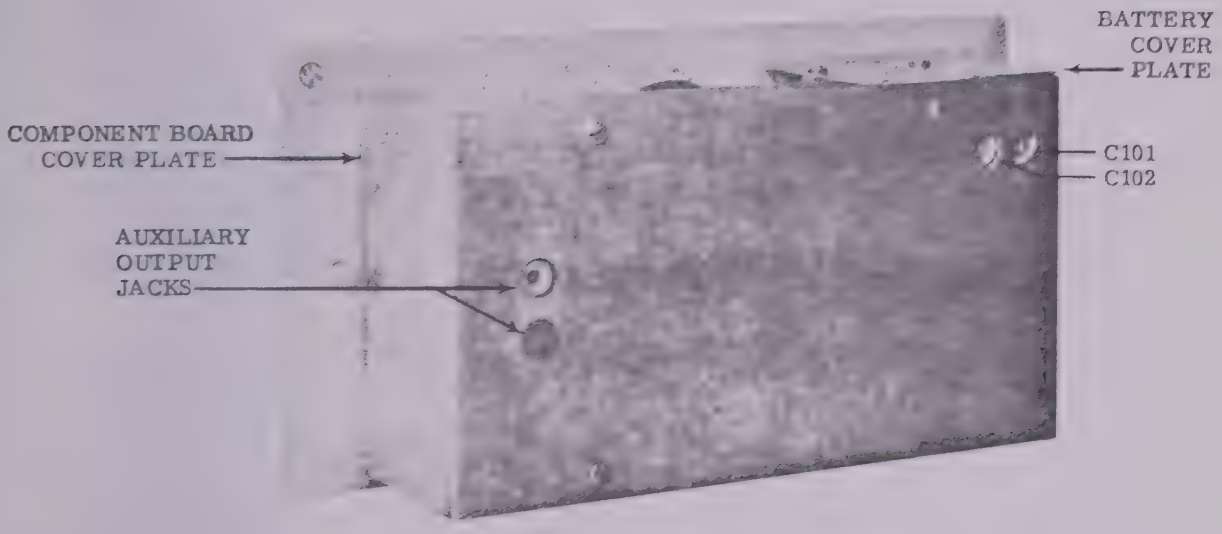
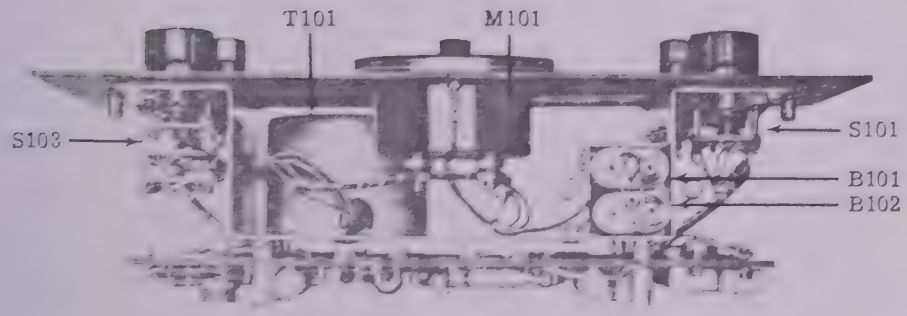
FIGURE 2

LOCATION OF CONTROLS AND CONNECTORS, MODEL NI-2



Rear View, Case Removed



Top View, Component Board and Battery Cover Plate Removed

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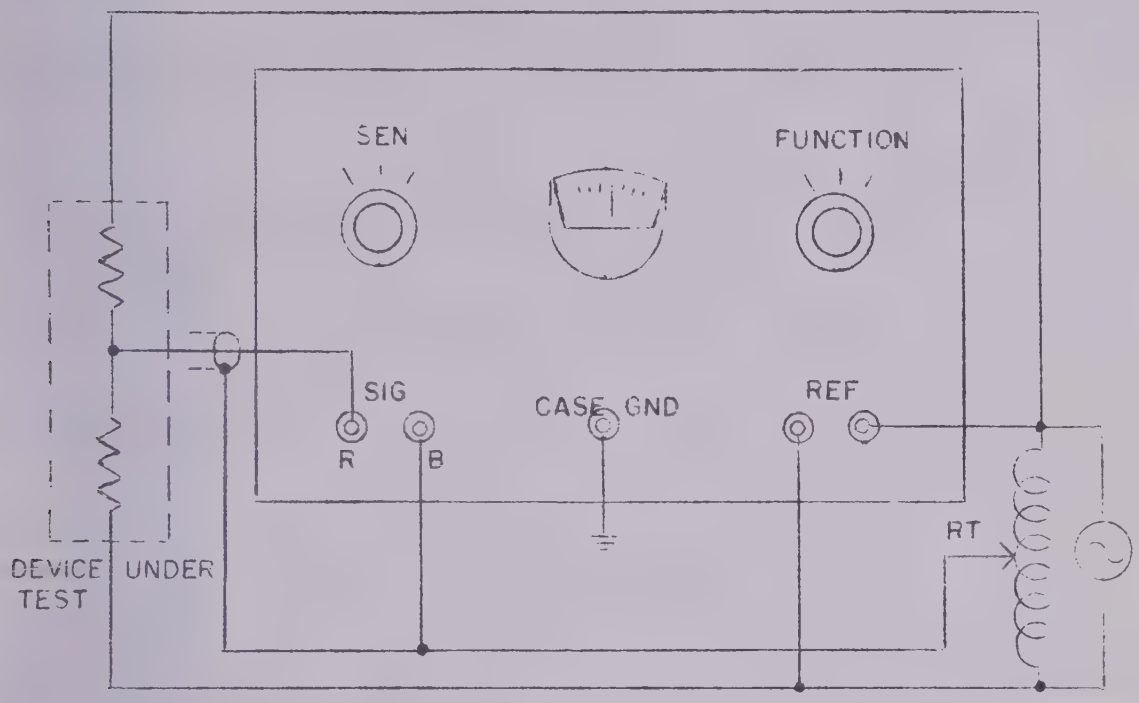
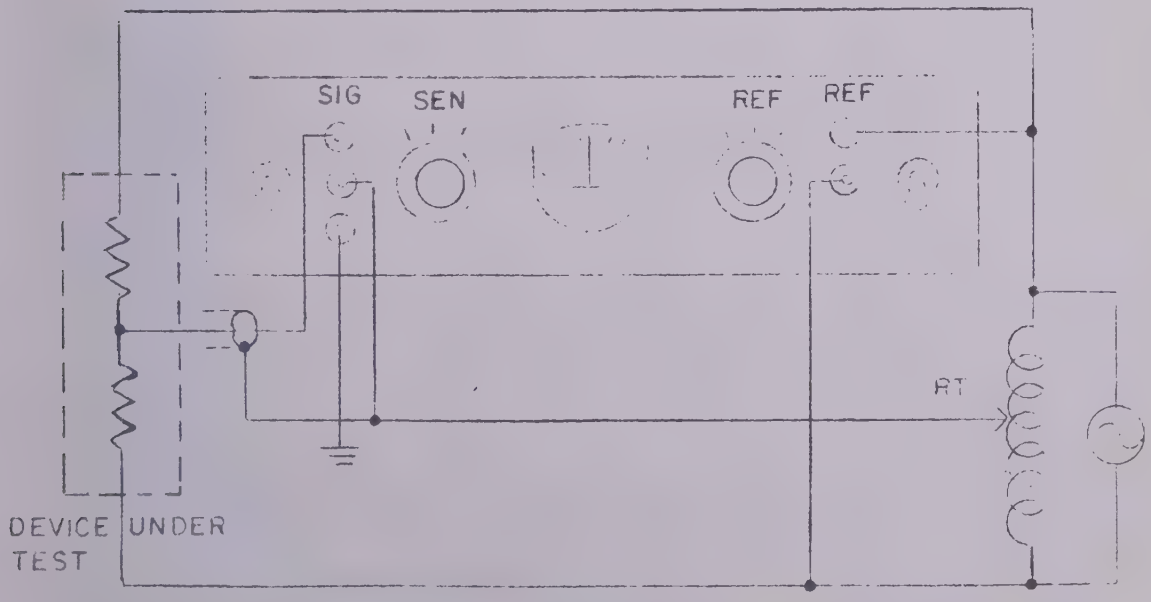
FIGURE 3

LOCATION OF CONTROLS AND CONNECTORS, MODEL NI-2

NI-2

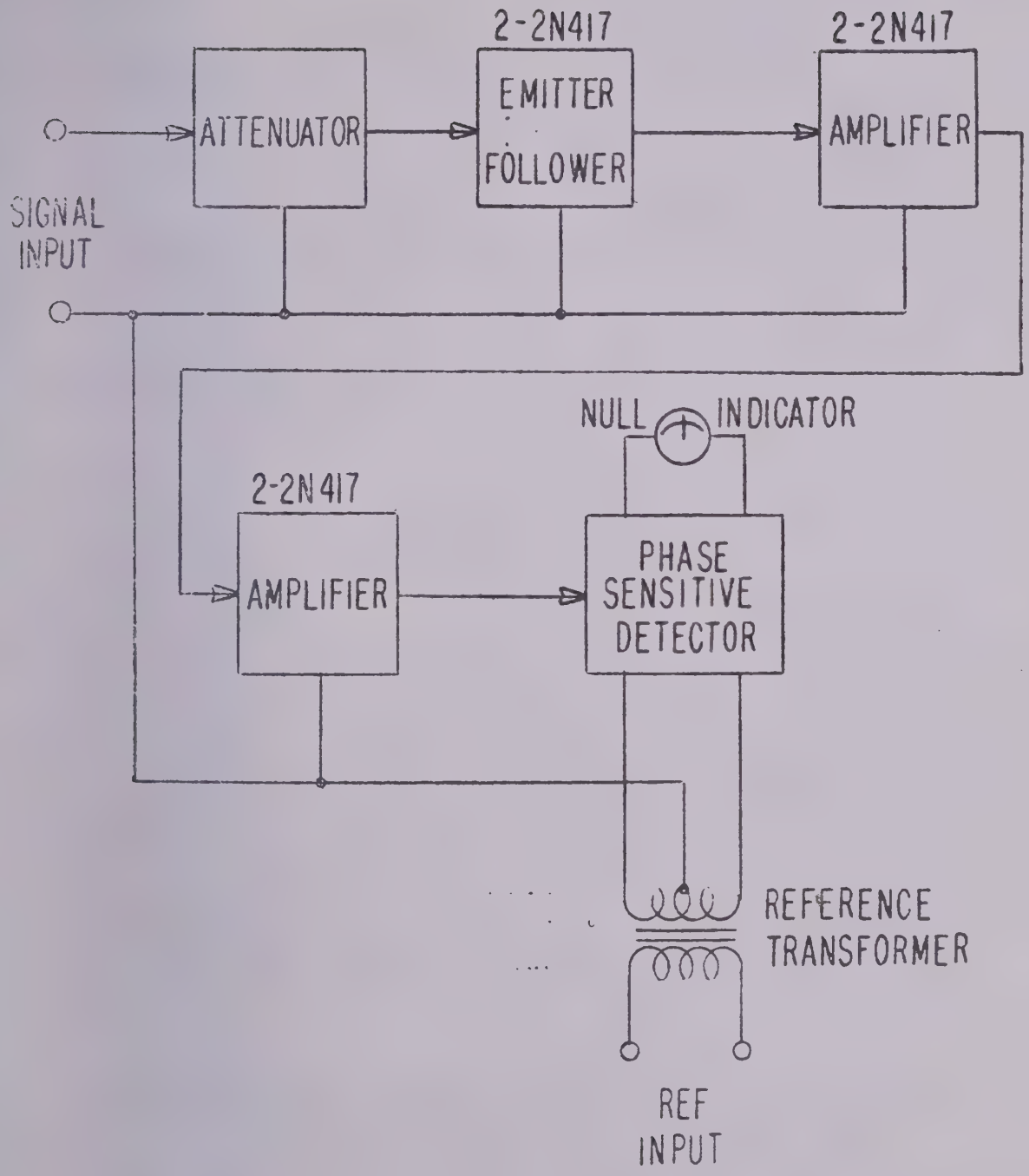


NI-3



TYPICAL TEST-SETUP

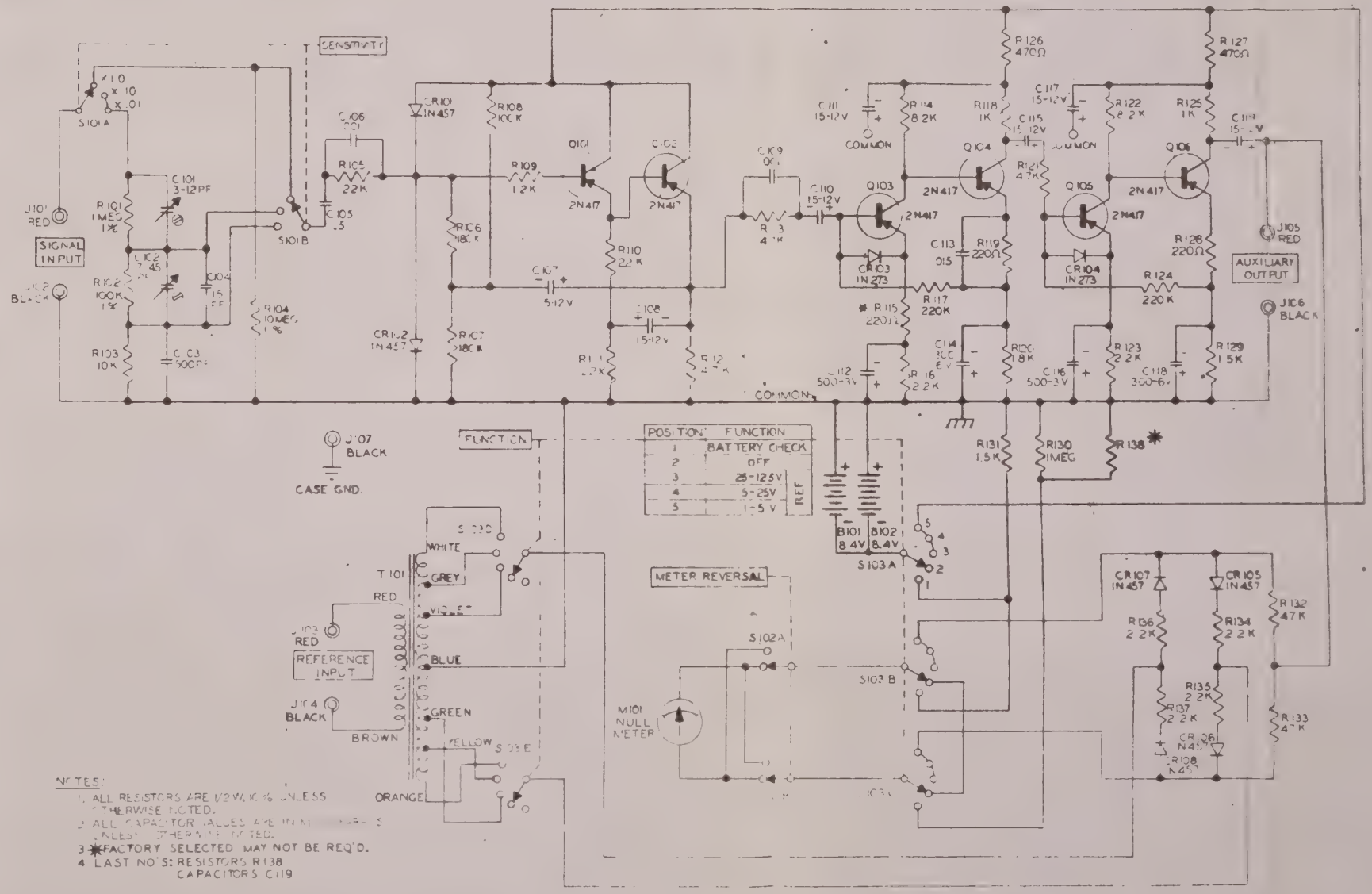
FIG 4



BLOCK DIAGRAM
FIG-5.

DO NOT SCALE DRAWING

MODEL BASED NO.		NEXT ASSY	NO. REQ.
NI-2			



D1-233 REV C

NOTES:
1. ALL RESISTORS ARE 1/2W, 10% UNLESS OTHERWISE NOTED.
2. ALL CAPACITOR VALUES ARE IN MFD UNLESS OTHERWISE NOTED.
3. ✱FACTORY SELECTED MAY NOT BE REQ'D.
4. LAST NO'S: RESISTORS R138
CAPACITORS C119

REV.	DESCRIPTION	DATE	APPROV.
A	ADDED R138	4-19-60	

SCALE | ITEM NO | DWG. SIZE | PART NO

MATERIAL

FINISH

DESCRIPTION: SCHEMATIC MODEL NI-2

TOLERANCE ± .010 UNLESS OTHERWISE SPECIFIED

SURFACE ROUGHNESS EXCEPT AS NOTED (PER MIL-STD-10)

REMOVE ALL BURRS AND SHARP EDGES COMMERCIAL TOLERANCES APPLY TO STOCK SIZES

GERTSCH PRODUCTS INC.

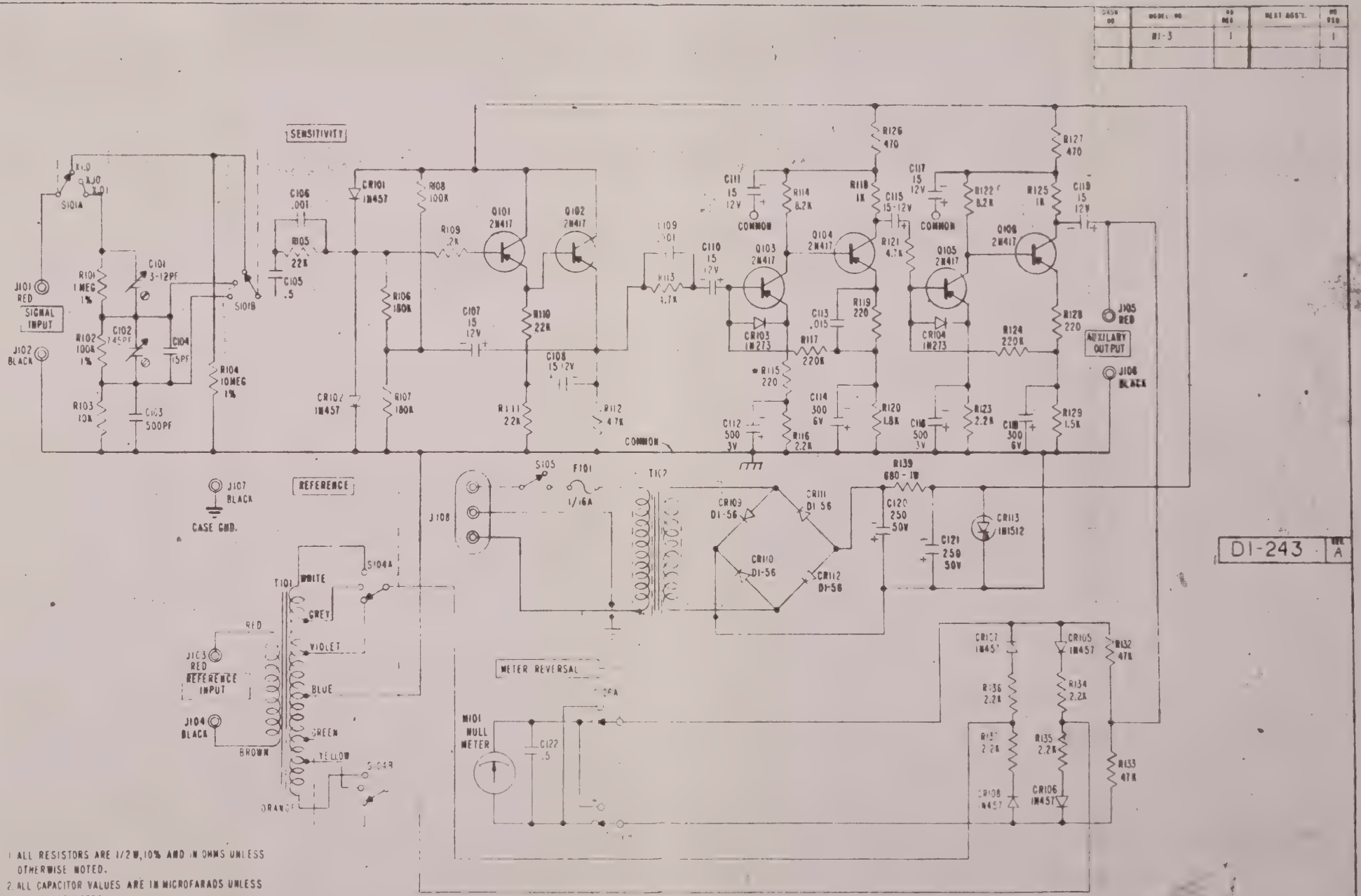
LOS ANGELES CALIFORNIA

	DR.	DATE
MECH. CHECK		
ELEC. CHECK		
MECH. APP.		
ELEC. APP.		4-19-60

SHEET ___ OF ___

-1 -2 -3 REQUIRED FOR

NO. D1-233 REV. C



DI-243 REV A

1. ALL RESISTORS ARE 1/2W, 10% AND IN OHMS UNLESS OTHERWISE NOTED.
2. ALL CAPACITOR VALUES ARE IN MICROFARADS UNLESS OTHERWISE NOTED.
3. * SELECTED VALUE.

SCALE NONE	ITEM NO.	DWG. SIZE	PART NO
MATERIAL			
FINISH			

LAST NO'S: RESISTORS R139
CAPACITORS C122
DIODES CR113

DESCRIPTION
SCHEMATIC DIAGRAM
MODEL NT-3

-1 -2 -3

TOLERANCE ± .010 UNLESS OTHERWISE SPECIFIED

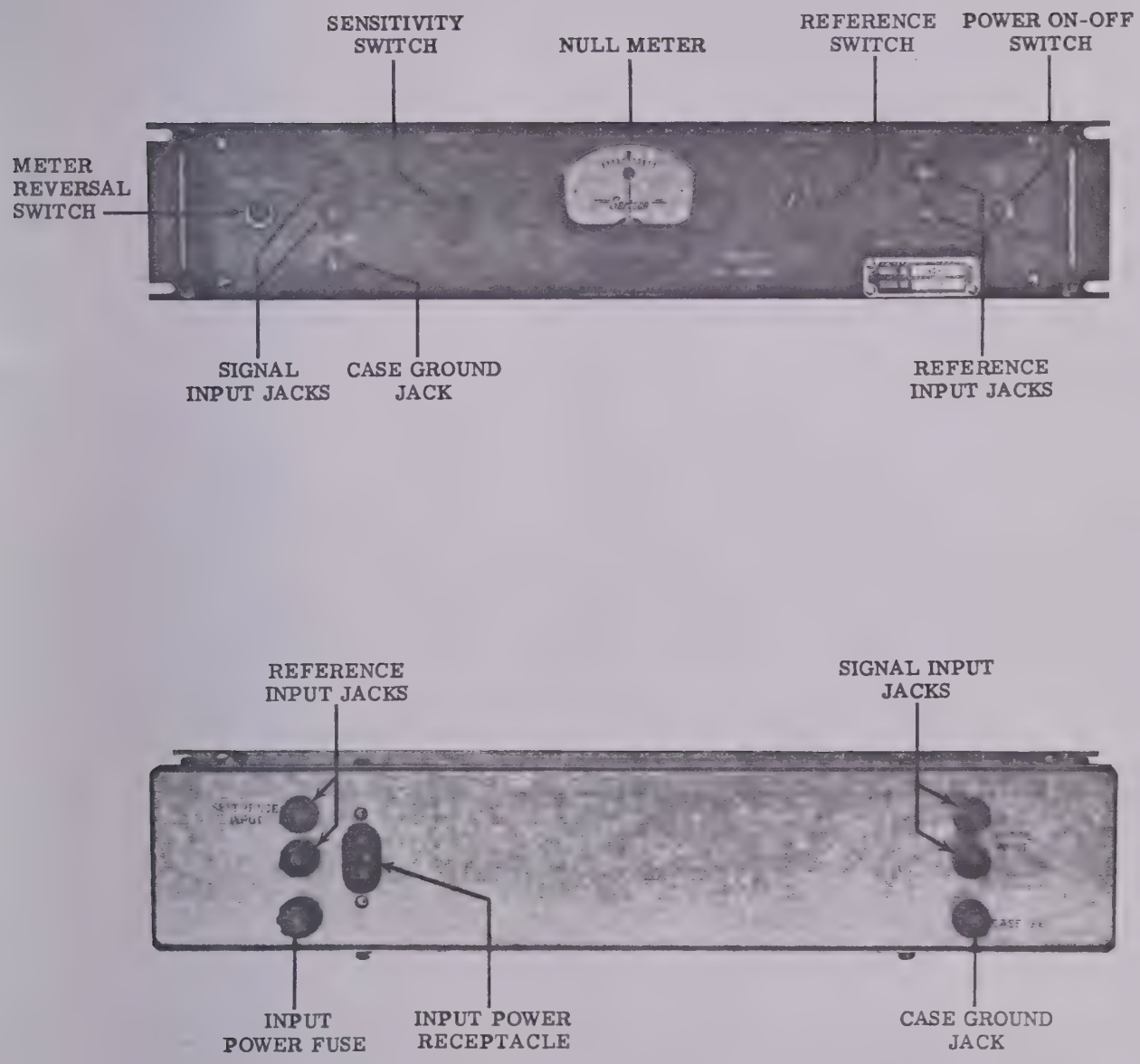
SURFACE ROUGHNESS EXCEPT AS NOTED (PER MIL-STD-10)

REMOVE ALL BURRS AND SHARP EDGES COMMERCIAL TOLERANCES APPLY TO OTHER DIMS

DR	BAKER	10-11-60	
MECH CHECK			
ELEC CHECK	GW	10-11-60	
MECH APP			
ELEC APP			

GERTSCH PRODUCTS INC.
LOS ANGELES CALIFORNIA

DI-243 REV A



45–50–1

FIGURE 8

LOCATION OF COMPONENTS, MODEL NI-3

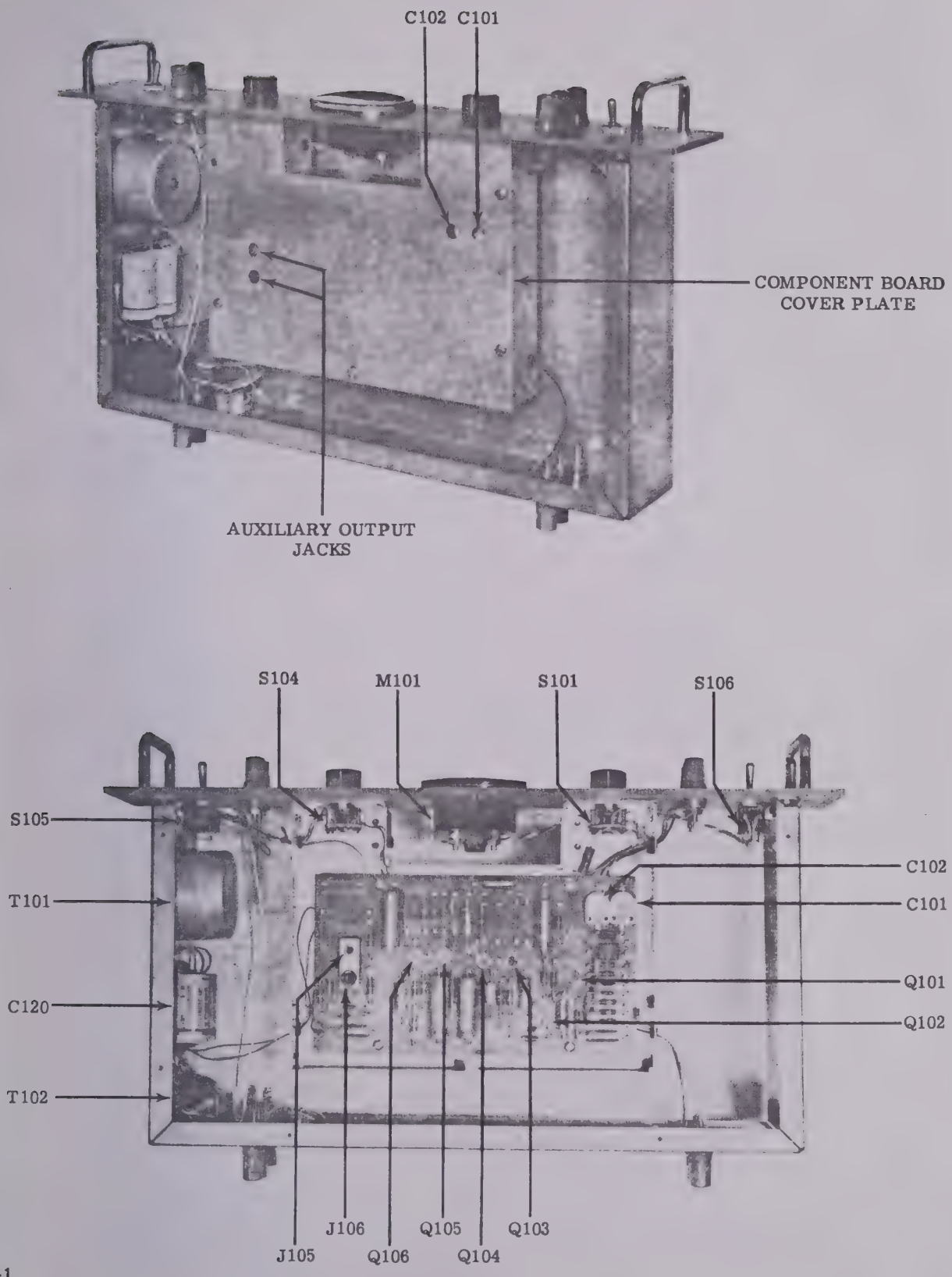
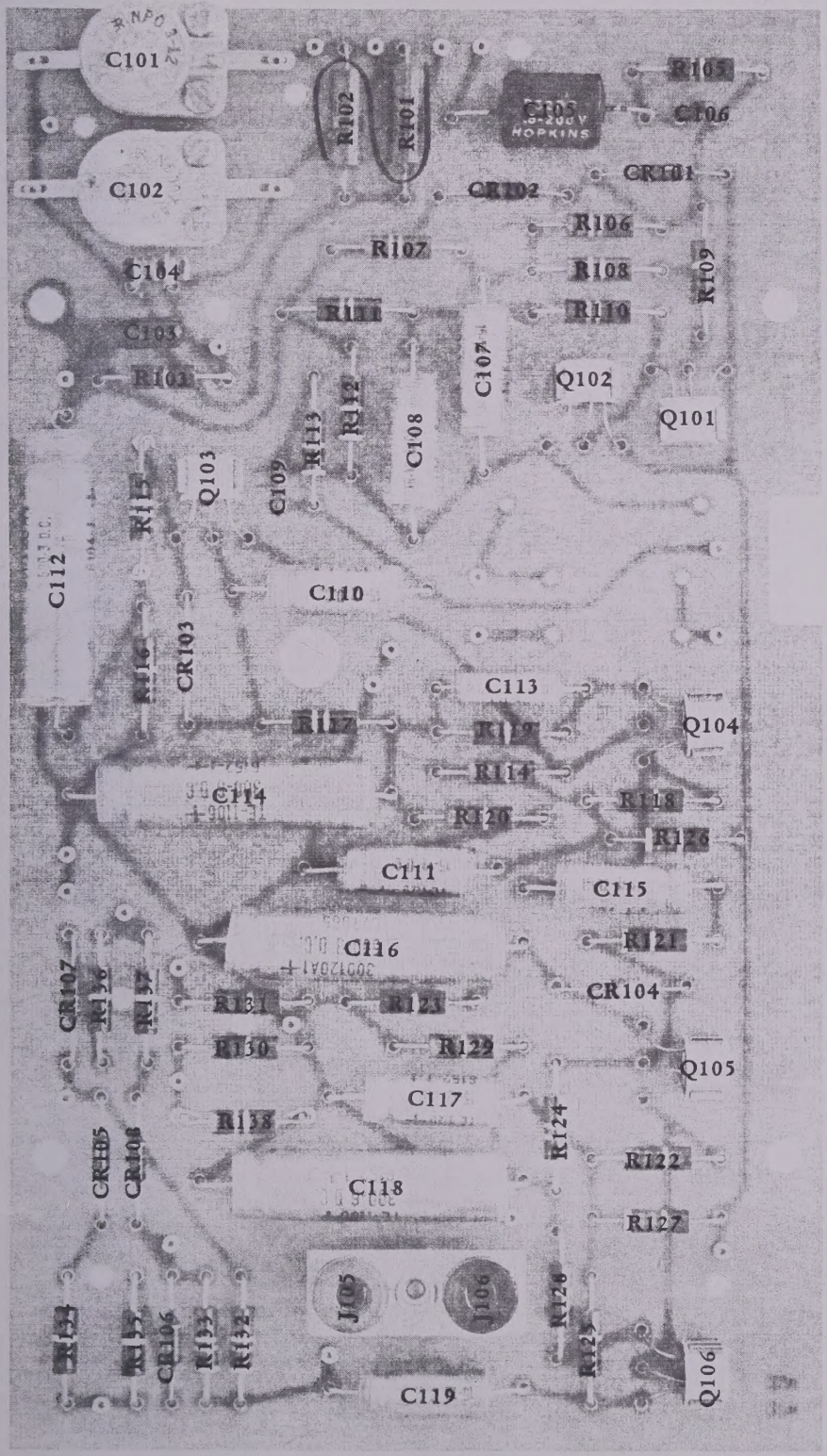


FIGURE 9

LOCATION OF COMPONENTS, MODEL NI-3



COMPONENT LOCATION OF PRINTED BOARD UNITS
MODEL NO. NI-2 AND NI-3

KEY TO FIGURE 10

1. R130
2. R131
3. C118
4. R129
5. Q106
6. R128
7. R124
8. R121
9. Q105
10. CR104
11. C115
12. Q104
13. R118
14. R114
15. C111
16. R126
17. Q103
18. R115
19. CR103
20. C112
21. R116
22. Q101
23. C102
24. C101
25. C103
26. C105
27. R105
28. R109
29. CR102
30. CR101
31. R106
32. R107
33. R108
34. C107
35. R112
36. R110
37. C108
38. R111
39. Q102
40. R113
41. C109
42. C110
43. R117
44. R119
45. C113
46. R120
47. C114
48. R123
49. C116
50. R122
51. R125
52. R127
53. C119
54. R132
55. C117
56. CR107
57. CR105
58. R136
59. R134
60. J106
61. R133
62. J105
63. R135
64. R137
65. CR106
66. CR108
67. C106
68. R103
69. R101
70. R102
71. C104